APPENDIX P

INFORMATION NEEDS FOR CLASS V INJECTION WELLS

INFORMATION NEEDS FOR CLASS V INJECTION WELLS
ELK HILLS POWER PLANT

ELK HILLS POWER, LLC

ELK HILLS OIL FIELD

KERN COUNTY, CALIFORNIA

March 31, 1999

Prepared by

San Joaquin Energy Consultants, Inc.

Bakersfield, California

Copy 2

INFORMATION NEEDS FOR CLASS V INJECTION WELLS

ELK HILLS POWER PLANT

ELK HILLS POWER, LLC

TABLE OF CONTENTS

LIST OF ATTACHMENTS

INFORMATION NEEDS FOR CLASS V INJECTION WELLS
ELK HILLS POWER PLANT

ELK HILLS POWER, LLC

1. GENERAL INVENTORY INFORMATION

A. Facility name, address, telephone:

Elk Hills Power Project
P. O. Box 1001
Tupman, CA 93276

(661) 763-6000

B. Property owner(s) name(s), address(es), telephone(s), including both surface and mineral rights owners):

Occidental of Elk Hills
P. O. Box 1001
Tupman, CA 93276

Telephone: (661) 763-6000

Chevron USA, Inc.
P. O. Box 1392
Bakersfield, California 93302

Telephone: (661) 395-6300

C. Operator/legal contact name, address, and telephone number of person responsible for facilities who can be contacted by Board staff:

Operator:

Elk Hills Power, LLC.
101 Ash Street
San Diego, CA 92101

Contact:

Mr. Dennis Champion
Occidental of Elk Hills
P. O. Box 1001
Tupman, CA 93276

(661) 763-6000

D. Project type (cogeneration, refinery, industrial treatment, commercial disposal, etc.):

Electric power generating plant with non-hazardous wastewater disposal wells.

E. Operating status of other well(s) on site:

There are no active, idle or abandoned wells within the project area of influence.

2. DATA: WELLS WITHIN AREA OF REVIEW

Volumetric and pressure front calculations indicate that the area of influence for this project is a 1,000-foot radius around each proposed injector. The area of review for this project was a quarter-mile radius around each injector (Attachment 1). There are no active, idle, or abandoned wells within this radius.

A. Legal contact(s) (name and address):

B. Well name and location (section, township, range, to be included in a table and on a map):

C. Date drilled (plus dates of significant workovers, abandonment date, etc.):

D. Well depth:

E. Type of well (hydrocarbon production, injection, dry, irrigation, domestic water supply, geothermal, etc.):

F. Status (active, inactive, plugged, abandoned, etc.):

G. Construction information (cement, casing, tubing, completion, and plugging records. Include "as built" diagram of each well showing construction, tops of injection and confining zones and formation tops):

H. Perforated and/or screened interval(s):

I. Distance from injection well(s):

J. Annotated copies of all lithologic, wire-line and geophysical logs, mechanical integrity tests, etc.:

K. Well history:

L. Contingency plan for well failures:

Depending on the type of well failure, e.g., casing split, cement bond breakdown, etc., appropriate action will be taken to continue injection service within the applicable Regional Water Quality Control Board (RWQCB) waste discharge requirements.

One well will be used as the primary injection well, with the other well available as a back-up injector. Wastewater can be diverted to the back-up well up to its maximum rate and pressure.

M. Corrective/remedial action for improperly abandoned well(s):

Not applicable.

N. Contingency plan for surface spills or equipment failure:

Depending on the type of failure, appropriate action will be taken to continue injection service within the applicable Regional Water Quality Control Board (RWQCB) waste discharge requirements. If only one well fails, the wastewater can be diverted to the other disposal well up to its maximum rate and pressure.

3. REGIONAL GEOLOGY

A. Regional structural geology:

The project area lies on the western side of the San Joaquin Basin in southernmost part of the Elk Hills oil field. The structure of the Elk Hills region consists of three major anticlinal structures: the 31S, Northwest Stevens, and 29R anticlines. The site lies along the synclinal axis that forms the Buena Vista Valley on the south flank of the 31S anticline. Attachment 2 shows a schematic geologic cross-section of the southern San Joaquin Basin through the Elk Hills area.

B. Regional stratigraphy:

The regional stratigraphy of the Elk Hills area consists of a thick section of sedimentary rocks ranging in age from Cretaceous to Recent. Miocene marine sedimentary rocks are overlain by a Pliocene sequence that represents the transition to near-shore and brackish water environments. The Pleistocene Tulare Formation consists of a non-marine section, primarily alluvial and fluvial sedimentary rocks. A generalized stratigraphic column is shown in Attachment 3.

C. Seismic activity:

Southern California experienced 19 major earthquakes from 1852 to 1993, ranging in Richter scale magnitudes from 5.9 to 8.0 (Foster Wheeler Environmental Associates, 1999). The largest recorded earthquake in the region was a Richter magnitude 7.7 in 1952. The Wheeler Ridge earthquake was a magnitude 5.2 event in 1993. The Ridgecrest earthquake occurred in 1995 and was a magnitude 5.4. Both events caused little structural damage.

No historically active faults occur in the Elk Hills area, but minor faults have been mapped in the field (Foster Wheeler Environmental Associates, 1999). The San Andreas fault lies 12 miles west of the field in the Temblor Range. Other major faults include the White Wolf fault and the Pond-Poso fault, which are located 25 miles southeast and 22 miles northeast, respectively.

The California Uniform Building Code (UBC, Section 2312) defines the area where Elk Hills is located as a seismic Zone 4 area, which is the highest potential on a scale from 0 to 4 (Foster Wheeler Environmental Associates, 1999). This category requires structural design considerations to protect buildings and other structures from earthquake effects.

4. HYDROGEOLOGY OF CONFINING ZONE FOR PROPOSED AND EXISTING WELLS

A. Formation:

Tulare clay in the upper Tulare Formation.

B. Age of confining zone:

Pleistocene.

C. Thickness of confining zone:

The thickness of the confining zone in the area of the proposed well locations is about 65 ft (Attachment 4).

D. Mineralogy and lithology of confining zone:

The Tulare clay consists primarily of buff to grayish tan, hard silty clay. Minor interbeds of silt, sand, and gravel may occur in the unit (Milliken, 1992).

E. Structure of confining zone (faults and extent, fractures):

The local structure of the confining zone consists of a west- to northwesterly-trending synclinal axis, which lies along the south-dipping flank of the 31S anticline. No faults appear to occur in the area of review. A structure contour map on the base of the Tulare clay is included as Attachment 5.

F. Stratigraphy of confining zone:

The confining zone is the Tulare clay in the upper Tulare Formation, which is a Pleistocene, non-marine deposit. The Tulare clay consists primarily of a relatively thick section of tan to grayish tan, hard, silty clay. See Attachment 6 for type log.

G. Description of vertical and lateral continuity of confining zone within a minimum one mile radius of the proposed injection well):

The Tulare clay appears to be areally extensive, with good continuity both laterally and vertically, as shown on an isopachous map of the zone (Attachment 5) and in cross-section (Attachment 7).

H. Hydrologic parameters of the confining zone:

1. Hydraulic conductivity or permeability (horizontal and vertical):

Information on the hydraulic conductivity or permeability of the confining zone will be provided.

2. Porosity:

Information on the porosity of the confining zone will be provided.

3. Compressibility:

Compressibility data for the confining zone will be provided.

5. HYDROLOGY OF INJECTION ZONE FOR PROPOSED AND EXISTING WELLS

A. Formation:

Sands and gravels of the upper Tulare Formation.

B. Age of injection zone:

Pleistocene.

C. Thickness of injection zone:

Average thickness = 1,150 ft. Net sand thickness = 750 ft average. See Attachment 8 for an isopachous map of the injection zone.

D. Mineralogy and lithology of injection zone:

The upper Tulare sands generally are very clean and well sorted and contain minor gravel. Sand beds commonly are interbedded with gravels (Milliken, 1992).

E. Structure of injection zone (faults and extent, fractures):

The local structure consists of a west-northwesterly-trending synclinal axis, which lies along the south-dipping flank of the 31S anticline. No faults appear to occur in the area of review. See Attachment 9 for a structure contour map on the top of the Amnicola clay.

F. Stratigraphy of injection zone:

The upper Tulare Formation is an alluvial and/or fluvial deposit consisting of interbedded gravels, sands, silts, and clays. See Attachment 6 for a type log.

G. Description of vertical and lateral continuity of injection zone within a minimum one mile radius of the proposed injection well:

Sands in the upper Tulare Formation appear to have good lateral and vertical continuity, as shown on an isopachous map of the zone (Attachment 8) and in cross-section (Attachment 7).

H. Hydrologic parameters of injection zone

1. Hydraulic conductivity or permeability (horizontal and vertical):

Permeability is estimated to be 4,835 md average based on core data from U.O. NPR No. 1 46WD-7G.

2. Porosity:

Porosity is estimated to be 34% average based on core data from U.O. NPR No. 1 46WD-7G.

3. Reservoir pressure:

261 psi based on U. O. NPR No. 1 well 45WS-18G; top of perforations at 974 ft.

4. Storage coefficient:

Information on the storage coefficient of the injection zone will be provided.

5. Compressibility:

Information on compressibility of the injection zone will be provided.

6. Formation fracture pressure:

<u>Well 1:</u> **424 psi, based on 0.8 psi/ft at top of perforations at 530 ft. 195 psi for surface injection pressure without friction loss.**

<u>Well 2:</u> **424 psi, based on 0.8 psi/ft at top of perforations at 530 ft. 195 psi for surface injection pressure without friction loss.**

Based on Division of Oil, Gas, and Geothermal Resources (DOGGR) fracture gradient of 0.8 psi/ft for southern San Joaquin Valley. Surface injection pressure neglects friction losses.

7. Depth of injection zone:

Approximately 530 ft.

8. Proposed perforation or screen interval (depth) within the injection zone:

Approximately 530 to 1,685 ft.

6. FORMATION WATER

Attachment 10 contains geochemical water analyses of Tulare formation water from wells located about one mile north of the project area.

A. TDS:

See Attachment 10.

B. Analysis of representative formation water sample to include trace elements and priority pollutants (EPA methods 624, 625, and metals):

See Attachment 10.

C. Description of sampling and analytical procedures:

Representative samples were collected using standard quality assurance/quality control (QA/QC) procedures in accordance with EPA methodology. A third-party laboratory analyzed the samples within the allowable holding times using EPA-approved methods (Attachment 10).

D. Direction and rate of regional groundwater flow:

Groundwater flows toward the south in Section 18, T31S/R24E, MDB&M, then drains easterly toward Buena Vista Lake (Attachment 11).

E. Direction and rate of injected fluid migration:

Injected fluid is anticipated to migrate radially away from the proposed injection wells.

F. TDS (salinity) profiles:

Groundwater TDS levels in the unconfined and confined aquifers are included in Attachment 12.

G. Specific gravity or density:

Density = 1.004 g/cm^3 (Attachment 10).

H. Temperature and pH:

pH = 7.0 at the time of collection for the sample shown in Attachment 10.

7. INJECTION FLUID CHARACTERISTICS

A. Narrative description of individual waste streams:

The wastewater to be injected into the proposed disposal wells will be obtained primarily from the cooling tower waste blowdown. The West Kern Water District (WKWD) will supply source water to the project via a new 9.8 mile, 16-inch pipeline extending from existing WKWD facilities. The water will be recycled approximately six times, resulting in a disposal stream that is chemically concentrated about 600 percent above the original source water. Additional process wastewater streams consist of plant area washwater, demineralizer resins regeneration wastewater, plant and equipment drains, filter backwash, and non-oil contaminated storm runoff.

B. Mix ratio (average, maximum, daily):

Estimated mix ratios of the various waste streams are summarized in the table below.

Waste Stream	Operational Process	Daily Average (gallons)	Daily Peak (gallons)
Cooling tower	Blowdown from cooling tower,	430,000	537,500

blowdown	evaporative cooler, and HRSG units		
Floor drains	Oily washwater and storm runoff pretreated in a oil-water separator	58,000	72,500
Demineralization waste	Wastewater from regeneration of demineralizer resins	15,000	18,500
Total waste		**503,000**	**628,500**

C. Constituent analyses to include trace elements and priority pollutants for individual and final waste stream(s) (EPA methods 624, 625 and metals):

Typical West Kern Water District geochemical analysis results are shown in Attachment 13. Total dissolved solids range to about 200 mg/l. The wastewater will be concentrated to a TDS of about 1,200 mg/l prior to injection (Attachment 14).

D. Detailed description of sampling and analytical methods, including quality assurance/quality control (QA/QC) procedures:

A sampling plan with QA/QC procedures in accordance with standard EPA methodology will be developed. The plan will include methods of collecting representative samples of the injectate, proper preservation techniques, and EPA-approved methods of analyses using a third-party laboratory. Samples will be analyzed within allowable holding times. A reporting format will be developed to ensure that the laboratory analyses are submitted to the various agencies in a timely fashion.

E. Temperature, pH, radiological characteristics:

The temperature of the cooling tower wastewater stream will normally be in the 80° to 85°F range. The pH will be approximately 8.0. The wastewater is not expected to demonstrate any radiological characteristics from this operation.

F. Compatibility of waste stream with receiving formation:

Although incompatibility of injectate and receiving groundwater is not anticipated, a compatibility analysis will be done and provided.

G. Density:

The specific gravity of the wastewater stream is expected to be approximately 1.05.

8. AREA OF REVIEW

A. Quarter mile radius or area of influence, based on stratigraphy, whichever is greater:

See Attachment 1 for map and Attachment 15 for calculations.

B. Zone of endangering influence over design life expectancy of well for both the pressure front and the waste front:

1. Volumetric method:

Waste front radius at 20 years = 995 ft. See Attachment 15 for calculations.

2. Pressure build-up method (e.g., modified Theis equation):

Pressure increase at 20 years and radius of 1,000 ft = 1.92 psia (4.4 ft of head). See Attachment 15 for calculations.

C. Calculation of dispersion or migration through the confining layer:

Negligible at injection pressure.

D. Modeling (if applicable, including model documentation):

Not applicable.

E. Narrative description, calculation and list of assumptions for each method:

Waste front calculations used methods described in Warner and Lehr, 1981, pp. 107-114. Pressure increases were calculated using superposition in an infinite-acting reservoir, assuming no fluid withdrawal. Assumed a 20-year service life for project and an average injection rate of 15,000 bbls per day per well.

F. Potential impact of injection upon wells within area of review (i.e., due to pressure build-up):

None. There are no other wells within area of review, nor would any significant impact be anticipated if there were other wells within the area of review (see Theis calculation).

9. INJECTION WELL CONSTRUCTION

A. Schematic design:

See Attachment 16.

B. Deviation check and frequency:

None.

C. Casing program (including thickness, diameter, nominal weight, joint specifications, lengths, etc.):

See Attachment 16.

D. Cementing program (quantity, location, additives, grade, cement bond logging, etc.):

Injection casing to be cemented from top of injection zone to surface.

E. Tubing:

See Attachment 16.

F. Packer (and other down-hole tools):

See Attachment 16.

G. Drilling/construction plan or well history:

From the *Application for Expansion of Water Disposal Permit #22800002* (Acord, 1998):

1. **Install 40 ft of conductor. Size to be determined based on final hole size requirements.**
2. **Drill 12 ¼" hole to TD (~2000 ft) with reverse circulating rig.**
3. **Run ~1500 ft of slotted (2" X 200M, 24R, 6"C) 8 5/8" csg on bottom of ECP with hydraulic stage tool and ~500 ft of blank 8 5/8" csg on top (weight and grade to be determined).**
4. **Cement 8 5/8" csg from ~500 ft (Tulare zone top) to surface. Drill out wiper plug.**
5. **Run 8 5/8" X 5" packer on tubing, set packer @ ~475 ft. Install injection tree. Place well on injection.**

H. Well completion (screened, tubing and packer, perforated):

See Item G above.

I. Well stimulation (description of methods):

See Attachment 17 for a typical well stimulation procedure.

J. Internal and external pressures, axial loading:

Assuming a top perforation at 500 ft, bottom perforations at 2,000 ft, and a maximum allowable injection gradient of 0.8 psi/ft; the maximum anticipated internal csg pressure at TD is calculated as follows:

Maximum Internal Casing Pressure = (0.8 psi/ft x 500 ft) + (2000 ft - 500 ft) x (0.434 psi/ft) = 1,051 psia.

Based on a current reservoir pressure of 261 psi at 974 ft, the maximum external casing pressure is expected to be 710 psi at ~2000 ft.

10. LOGGING PROGRAM

A dual induction log will be run across the Tulare zone after the well is drilled to TD. A cement bond log will be run from the top of the zone to surface after the casing is cemented in place.

A. Pertaining to surface casing:

1. Before casing & cementing: resistivity, SP, Gamma Ray, neutron, caliper logs, etc.:

See discussion at top of section.

2. After casing & cementing: cement bond, temperature, gamma ray, neutron logs, etc.:

See discussion at top of section.

B. Pertaining to intermediate and long string casing

1. Before casing & cementing: resistivity, SP, gamma ray, porosity, density, sonic, caliper logs, etc.:

See discussion at top of section.

2. Fracture locating logs:

See discussion at top of section.

3. After casing & cementing: cement bond, temperature, gamma ray, neutron logs, etc.:

See discussion at top of section.

4. Approved alternative surveys (e.g., radioactive tracer, spinner, etc.):

See discussion at top of section.

C. Lithologic logs, mud logs:

A mud log will be maintained on at least one of the proposed disposal wells.

D. A descriptive log interpretation report prepared by a knowledgeable log analyst:

As necessary.

11. PLUGGING AND ABANDONMENT

A. Narrative description of cement plug placement (well in static equilibrium)

Proposed disposal wells will be abandoned in accordance with EPA, DOGGR, and other applicable requirements in force at the time when wells are abandoned.

1. Balance method:

2. Dump bailer method:

3. Approved alternate method:

B. Schematic diagrams (full detail):

To be provided.

C. Cementing program (type, quantity, grade, additives, and location of cement and drilling fluids):

Cementing program will be approved by the EPA, DOGGR, and other applicable requirements in force at the time when wells are abandoned.

12. MAPS

A. Topographic map: USGS quadrangle sheet as base map. (Map should extend a minimum of one mile beyond the property boundaries.) At a minimum the base map needs to illustrate the following:

1. Surface facilities:

See Attachment 1 and Attachment 18.

2. Project area:

See Attachment 1.

3. Public water supply facilities:

Not applicable.

B. Topographic map: Showing all wells in project area (same scale as above)

1. Well ID (name and number):

See Attachment 1.

2. Type (production, injection, irrigation, water supply, enhanced recovery, monitoring):

See Attachment 1.

C. Geologic map (same scale as above):

See Attachment 19.

D. Structural contour maps (mapped on top of injection and confining zones, both regional and site specific):

See Attachment 5 and Attachment 9 for structure contour maps on the base of the Tulare clay and the top of the Amnicola clay, respectively.

E. Geologic cross-sections :

1. Geologic formations:

See Attachment 7 for cross-sections.

2. Structural features:

See Attachment 7 for cross-sections.

3. Shallow aquifers:

See Attachment 7 for cross-sections.

4. TDS levels for each formation, including sources of data:

Data will be provided.

5. Underground sources of drinking water:

Exempted by DOGGR as a source of drinking water based on petroleum production in the zone (Attachment 20).

6. Injection zone:

See Attachment 7 for cross-sections.

F. Stratigraphic column (by formation)

1. Lithology:

See Attachment 6 for type log.

2. Mineralogy:

See Attachment 6 for type log.

3. Physical features (texture, bedding, etc.):

See Attachment 6 for type log.

4. Thickness:

See Attachment 6 for type log.

5. Formation hydraulic conductivity or permeability:

See Attachment 6 for type log.

6. Porosity:

See Attachment 6 for type log.

7. Salinity profile (TDS):

See Attachment 6 for type log.

8. 10,000 mg/l and 3,000 mg/l TDS baseline (freshwater baseline):

To be provided.

9. Geologic time scale:

To be provided.

G. Isopach maps (minimum one-mile radius from injection well)

1. Confining zone (total unit and net clay):

See Attachment 4 for isopachous map of the Tulare clay.

2. Injection zone (total unit and net sand):

See Attachment 8 for isopachous map of the upper Tulare injection zone.

H. Area of review (on topographic map showing proposed and existing well locations). Illustrate area(s) of influence as calculated by the following methods for both pressure front and waste front)

1. Quarter mile radius or area of influence, whichever is greater:

See Attachment 1.

2. Pressure build-up method for both individual and multiple well operations.

See Attachment 1.

3. Volumetric method.

See Attachment 1.

4. Modeling output (if appropriate).

Not applicable.

I. A map showing all wells within one-mile radius of the proposed injection well(s) that produce oil or gas from the injection zone and/or confining zone.

See Attachment 1.

13. OPERATING DATA

A. Injection rate (average and maximum, in barrels per day and million gallons per day) and describe any daily or seasonal variations:

The maximum anticipated injection rate is 15,000 barrels of water per day.

B. Injection pressure (average and maximum), injection pressure gradient at top of injection zone not to exceed 0.8 psi/foot without approval:

Based on a top perforation depth of 500 ft and a maximum allowable injection gradient of 0.8 psi/ft, the maximum anticipated surface injection pressure is approximately 180 psia.

C. Annular fluid (type, volume, additives, pressure, density, specific gravity, etc.):

Tulare formation water treated with corrosion inhibition chemicals shall be used as annular fluid.

D. Results of injectivity testing:

To be determined.

E. Calculate hydrofracture pressure for zone and method used to derive pressure limit:

Step-rate tests done on Tulare injection wells approximately one mile north of the project area have demonstrated a hydrofracture gradient greater than 0.95 psi/ft in this zone.

14. MONITORING

A. Describe any proposed monitoring programs

1. Mechanical integrity monitoring and reporting program:

Well surveillance and mechanical integrity testing shall conform to EPA, DOGGR, and other applicable requirements in force throughout the life of the injection wells.

2. Ground water monitoring program (if applicable):

Not applicable.

15. SURFACE TREATMENT FACILITIES

A. Process diagram (with descriptions of individual units):

See Attachment 14.

B. Narrative process description:

The proposed project consists of a gas-fired combined cycle power plant and associated linear facilities. The project will have a nominal electric power output of 500 MW and will be fueled with natural gas from the Elk Hills Oil and Gas Field. Natural gas will be delivered to the project via a new 2,500-foot, 10-inch pipeline extending from an existing gas pipeline from nearby gas processing facilities operated by Occidental Of Elk Hills. Power will be sold into the PG&E transmission system. Water for the project will be supplied by the West Kern Water District (WKWD) via a new 9.8-mile, 16-inch supply line extended from existing WKWD facilities. Wastewater will be disposed of into two proposed disposal wells, located about four miles south of the power plant site. Steam from the power plant will be used to generate electricity and will not be used for oil field production.

C. Disposal of sludge and hazardous materials (if applicable):

Not applicable.

D. Effectiveness of pretreatment (removal efficiencies):

Not applicable.

E. Hazards associated with precipitation and flooding, and any proposed mitigation methods:

Not applicable. Area is outside the 100-year floodplain, based on the Army Corps of Engineers (1993) and FEMA (1986) (Foster Wheeler Environmental Associates, 1999).

16. FINANCIAL ASSURANCE

A. Financial assurance demonstration to indicate ability to maintain resources to close, plug, and abandon the injection operations in a manner consistent with the Underground Injection Control program regulations. (Include a detailed listing of cost estimates, and adjustment for inflation over life of project. California Division of Oil & Gas bond values based on depth are inadequate.):

Financial assurance demonstration will be provided.

17. REFERENCES

Acord, J., 1998. *Application for Expansion of Water Disposal Permit #22800002*, report prepared for Occidental of Elk Hills, Inc.

Bean, R. T., and Logan, J., 1983. *Lower Westside Water Quality Investigation, Kern County*, report prepared for Calif. State Water Resources Control Board.

Farley, T., 1990. "Heavy Oil Reservoirs in the Tulare Fold Belt, Cymric-McKittrick Fields, Kern County, California" in Kuespert, J. G., and Reid, S. A., eds., *Structure, Stratigraphy and Hydrocarbon Occurrences of the San Joaquin Basin, California*: Pacific Sections of SEPM, and AAPG.

Fishburn, M. D., 1990. "Results of Deep Drilling, Elk Hills Oil Field, Kern County, California" in Kuespert, J. G., and Reid, S. A., eds., *Structure, Stratigraphy and Hydrocarbon Occurrences of the San Joaquin Basin, California*: Pacific Sections of SEPM, and AAPG.

Foster Wheeler Environmental Associates, 1999. *Application for Certification for Elk Hills Power Project, Kern County, California*: report prepared for Elk Hills Power, LLC for submittal to California Energy Commission.

Milliken, M. D., 1992. "Geology and Geohydrology of the Tulare Formation, 7G/18G Produced Water Disposal Area, South Flank NPR-1", report prepared for U. S. Dept. of Energy Naval Petroleum Reserves in California Technical Report.

Nicholson, G. E., 1990. "Structural Overview of Elk Hills" in Kuespert, J. G., and Reid, S. A., eds., *Structure, Stratigraphy and Hydrocarbon Occurrences of the San Joaquin Basin, California*: Pacific Sections of SEPM, and AAPG.

Phillips, M. V., 1992. *Summary of Tulare Formation Groundwater Conditions along the South Flank of Naval Petroleum Reserve No. 1, Elk Hills, Kern County, California*: report prepared for U. S. Department of Energy Naval Petroleum Reserve.

Reid, S. A., 1990. "Elk Hills Field Overview" in Kuespert, J. G., and Reid, S. A., eds., *Structure, Stratigraphy and Hydrocarbon Occurrences of the San Joaquin Basin, California*: Pacific Sections of SEPM, and AAPG.